JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES
VOL. 31 FEBRUARY 15, 1941 No. 2

GEOCHEMISTRY.—*Time and temperature effects in the formation of colloidal dispersions.*[1] P. G. NUTTING, U. S. Geological Survey.

Many colloids disperse in water much after the manner of salts going into solution. There is commonly a concentration limit or solubility, affected by temperature and by the presence of other salts or colloids. The rate of dispersion depends upon the same factors affecting rate of solution. The concept of peptization is evidently too narrow to deal with colloidal dispersion. On the other hand, dispersions may be treated as solutions if their common tendency to reaggregate in micellae of a wide size range (comparable to polymerization in ordinary chemistry) be kept in mind. With complex colloids in acid solution, dispersion and solution may occur together, and the study of such solutions throws much light on many soil and geologic problems.

The writer has investigated at some length the behavior of various montmorillonite clays in acids of various concentrations and various ratios of acid to clay.[2] In these studies a 48-hour digestion at 90° C. was commonly used. Here reported are digestions at 90°, 3 hours to 11 days, and at 28°, 1 to 128 days, each in 8 steps. The latter shows an interesting case of recombination of ions with colloidal micellae well worth recording.

The clay used was the purest montmorillonite bentonite known, from the Vicksburg formation near Polkville in central Mississippi. It is practically 100 percent crystalline, and most of the crystals (montmorillonite) are assembled in shard relicts indicating that no reworking had occurred. For use it was withdrawn from storage in a saturated atmosphere and room-dried to permit grinding to 150 mesh (0.1 mm). Twenty grams of this clay was put in 4 liters of 0.4 percent HCl previously brought to temperature (28° for one run, 93° for the other) and vigorously stirred at intervals. At the stated time inter-

[1] Published by permission of the Director, Geological Survey, U. S. Department of the Interior. Received November 20, 1940.

[2] NUTTING, P. G., *A study of bleach clay solubility.* Journ. Franklin Inst. **224**: 339. 1937. Also, *Study of a magnesium clay.* Journ. Washington Acad. Sci. **30**: 233. 1940.

vals, 400 cc of solution was withdrawn and filtered for analysis. The filtration, through the clay itself on Whatman 42 paper, was continued until the filtrate showed little or no scattered light (Tyndall beam) in a very strong light beam. This means an upper limit to particle size of less than 0.1 micron.

These 400-cc portions of filtrate were evaporated to dryness in

TABLE 1.—SOLUBILITY OF CLAY AT 93° C.

Time of treatment	Water insoluble	Soluble R_2O_3	Soluble CaO	SiO_2	Combined R_2O_3	$\frac{SiO_2}{\text{Insoluble}}$	$\frac{\text{Combined } R_2O_3}{SiO_2}$
3 hours...	0.2572	None	0.0630	0.1652	0.0343	0.642	0.208
7 hours...	0.4732	None	0.0951	0.2962	0.0979	0.626	0.330
24 hours...	0.8588	None	0.0961	0.4918	0.1912	0.573	0.389
2 days....	1.2500	0.0238	0.0966	0.6295	0.2932	0.504	0.465
4 days....	1.5671	0.1518	0.1071	0.8628	0.3748	0.551	0.434
6 days....	1.7648	0.1786	0.1280	0.8484	0.4754	0.481	0.560
8 days....	1.7639	0.2036	0.1424	0.8472	0.5106	0.480	0.603
11 days....	1.7731	0.2425	0.2019	0.8492	0.5808	0.479	0.684

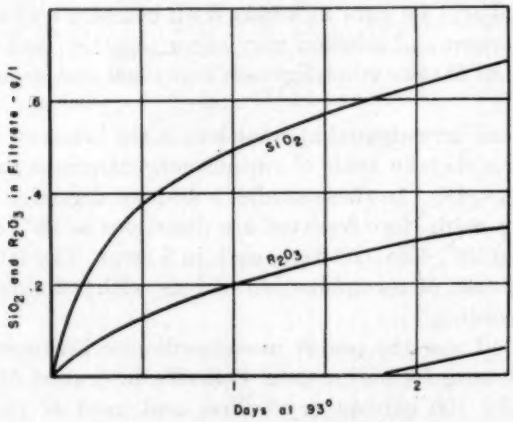


Fig. 1.—Solubility of clay at 93° C.

150-cc pyrex beakers, then put in an oven at 160° for an hour to remove all free moisture. Check tests showed no appreciable vaporization or insolubilization of the mixed chlorides (chiefly of Al, Fe, and Ca with traces of Na and K) present by this treatment. After the total residue was weighed, water soluble chlorides were removed by boiling 10 minutes in distilled water, decanting, and the residue again dried at 160°. This water-insoluble residue, after weighing, is wet with

concentrated HCl, then treated with about 15 cc of hot 20-percent HCl for 30 minutes to separate bases from silica.

The results obtained at 93° are given in Table 1 and graphed in Fig. 1, expressed in grams per liter.

As regards silica and water-insoluble residue, the solution appears to approach saturation in about 4 days, half saturation in about 1 day. Silica approaches 0.85 gram per liter as a limit, water-insolubles 1.8. Water-soluble R_2O_3 first appears in the 2-day digestion but combined R_2O_3 appears in 3 hours. Both forms of R_2O_3 appear to be still increasing after 11 days. The CaO in this clay is not all removed at the start as with some clays, but only about a third in the first 3 hours. Calcium does not recombine (like part of the R_2O_3) in this dilute acid solution. A pH of 1.56 was taken after 8 days. After 5 months at room temperature (28°) the pH of this solution was 0.93, and the water soluble R_2O_3 had decreased to nothing.

In the original clay, SiO_2 was about 68 percent of the total solids. In these solutions that ratio starts at 64 and drops toward 48, which is below the $Al_2O_3 \cdot 2SiO_2$ ratio. In the clay, R_2O_3/SiO_2 is about 0.40, while in the washed residue that ratio ranges from 0.2 to nearly 0.7 and is still rising in the 8–11 day interval. Pure silica is soluble in water at 90° to the extent of 0.418 gram per liter, less than half the maximum (0.85) here attained. Acid depresses the solubility of silica in water, but by dissolving bases from the clay it releases silica to go into solution in the water and there recapture the bases previously associated with it. MgO constitutes 4.5 percent of this clay, but no more than traces were ever found in solution. The chlorides of aluminum and iron undoubtedly hydrolize in solution, thus setting free more acid as these bases reunite with silica. Until these chlorides leave the clay, the associated water is insufficient for hydrolysis.

At 28° the solution of clay in 0.4 percent HCl is not only very much slower, but an essentially different process. As before, 20 grams of 150-mesh Polkville clay was put in 4 liters of 0.4 percent hydrochloric acid in a pyrex flask. The temperature of the room (air conditioned) seldom rose above 29° or fell below 27° and then only for brief periods. At intervals, 400-cc portions were withdrawn, filtered, and analyzed as described above. The results (in grams per liter) are shown in Table 2 and graphed in Fig. 2.

No trace of water-soluble R_2O_3 was found in any of the first residues; all that is dissolved from the clay recombines with the silica in solution. There is no indication of any saturation limit being approached in 128 days. Silica apparently passes through a minimum

TABLE 2.—SOLUTION OF CLAY IN ACID AT 28° C.

Days of treatment	Water insoluble	CaO soluble	SiO_2	Insoluble R_2O_3
1.....	0.0220	0.0837	0.0141	0.0007
2.....	0.0337	0.0751	0.0066	Trace
4.....	0.0425	0.0760	0.0008	None
8.....	0.0796	0.0727	0.0258	0.0136
16.....	0.1157	0.0929	0.0817	0.0177
32.....	0.1984	0.0938	0.1187	0.0281
64.....	0.4061	0.1026	0.2469	0.0605
128.....	0.6508	0.1138	0.3682	0.1492

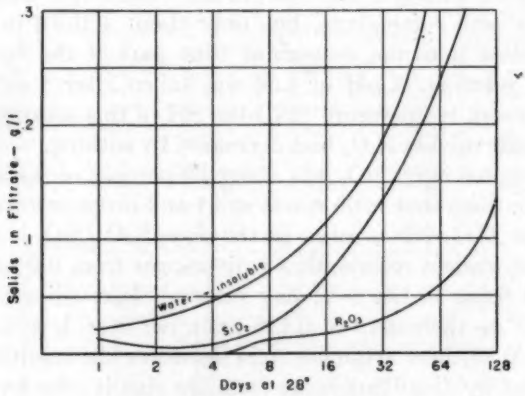


Fig. 2.—Solubility of clay at 28° C.

during the first few days, then rises steadily. Water-insoluble solids increase from the start. Recombined R_2O_3 appears after 4 days, remains low for a month, then rises rapidly. The ratio SiO_2/water-insoluble remains approximately constant (average 0.58) instead of decreasing to a minimum as it does at 90°. The saturation limit for pure silica (0.195 gram per liter at 28°) is passed in about 50 days and is nearly double this in 128 days.

The adsorption of ions on colloidal micellae is well known to chemists. The results here reported afford a quantitative view of the mechanism of one such process familiar to geologists in which the micellae are submicroscopic and approach true solution.

In soils, alternately wet (with slightly acid water) and dried, conditions are evidently very favorable for the formation of montmorillonitic particles from the mother rock substance. Soil acids dissolve the bases while water dissolves the silica. In solution, the salts hydrolyze (as they could not in the rock), and the bases recombine with the

silica. Drying precipitates the colloid. The occurrence of montmorillonitic clays in rock seams or filling cavities in quartz crystals and as replacements of shells and decomposed granite is readily understandable. Elements not needed in the recombination are excluded; thus dendrites of manganese oxide and specks of chromite and biotite are commonly found associated with clays of this type.

Many possible disturbing factors were investigated and may be briefly mentioned. Adding excess acid to the filtrate before evaporation does not affect the analysis, nor does the addition of ammonia up to the point where precipitation begins. If excess pure silica solution is added, that silica remains uncombined with the bases. In one series of tests, sodium fluosilicate, Na_2SiF_6, was added in varying amounts from 0.01 to 0.14 gram in 400 cc of clay solution, but no effect on the silica or on either soluble or insoluble R_2O_3 was found. The anion effect in solution analysis is large. Oxalic, phosphoric, and sulphuric acids depress or inhibit recombination (of R_2O_3 with silica) in solution, while nitric acid forces all R_2O_3 into combination with silica, despite the high concentration reached during evaporation. The behavior of clays in different acids will be reported in a later paper.

SUMMARY

Solutions of montmorillonitic clay in dilute hydrochloric acid, at either 28 or 90° C., may contain more than twice the silica of a saturated solution of pure silica in water.

Part of the sesquioxides leave the clay and combine with silica to form submicroscopic colloidal particles recoverable by evaporation.

At 90° equilibrium is approached in 4 days; at 28° solution curves are still rising after 128 days.

The possible bearing of these results on the formation of clay colloids in rock cavities and soils is discussed.

BOTANY.—*Naming the cultivated rubber tree* Siphonia ridleyana.[1]

O. F. Cook. U. S. Bureau of Plant Industry.

As indicated in Science,[2] historians of the rubber industry are seriously misled by confusion among the names of different trees in South America. The usual designation of the cultivated rubber tree is *Hevea brasiliensis*, but this is ambiguous on account of being borrowed from two other rubber trees. The generic name *Hevea* was transferred from a tree found by La Condamine in 1736 on the Pacific coast of Ecuador, and the specific name *brasiliensis* from a tree that Humboldt and Bonpland collected on the upper Orinoco in 1800. The generic name *Siphonia* has historic warrant for replacing *Hevea*, as will be explained. The specific name *Siphonia ridleyana* is suggested to commemorate the discovery by Henry N. Ridley of the method of extracting the rubber-bearing latex of this tree, which may be reckoned among the major events of history. No other domestication or introduction of a plant has such marked reactions on human affairs. The rubber discovery was made at the Singapore Botanic Gardens in 1889, as recounted by David Fairchild in the Journal of Heredity for May, 1928, from notes of a visit to Ridley in 1896.

Giving the cultivated rubber tree a name of its own may assist in clarifying some of the problems of production. This tree has been the subject of intensive investigation in the East Indies, but has had relatively little study in tropical America. The cultural problems are not the same in America, and a different approach is necessary on account of the *Castilla* or Central American rubber tree being much better known in most of the American countries. The original habitat of the cultivated rubber tree was in the lower Amazon Valley, while *Castilla* extended through tropical America from Mexico to Peru, Bolivia, and Brazil, several species being recognized.

Without Ridley's discovery there would have been no commercial planting of *Siphonia* in the East Indies, higher prices would have ruled, and some of the *Castilla* plantations in Mexico and Central America would have been profitable. In that event the planting of *Castilla* might have extended through tropical America and our present dangerous dependence on the East Indies would not have occurred. Markham's project of cultivating rubber in the East Indies would have miscarried, and Wickham's rape of the Brazilian rubber tree, dramatized by so many historical writers, could have had little significance. The industrial utilization of rubber doubtless would have

[1] Received December 30, 1940.
[2] Science 85: 406–407. 1937.

gone forward but in different courses and much more slowly. The exploitation of wild rubber in Brazil would have been carried into more remote forests, with increasing difficulty and hardship among the laboring people, till cost limits were reached, or demands could be met from planted *Castilla* rubber. Planting *Siphonia* in Brazil was not feasible under the native method of tapping, and the native leaf disease is another obstacle not yet surmounted.

CASTILLA THE ORIGINAL RUBBER TREE

A general priority may be claimed for *Castilla* as a source of rubber, not only in Mexico and Central America, but also in South America. The labor required for gathering *Castilla* rubber is much less than with *Siphonia*, on account of the latex being more abundant and flowing more freely, but the trees are destroyed. It was not till the middle of the nineteenth century, after *Castilla* had been exhausted along the Amazon, that the Para rubber tree began to be exploited on a large scale. The extinction of *Castilla* is explained by the method of tapping, the trees being felled and ringed with tapping cuts at frequent intervals along the whole length of the trunk and the larger branches. Fifty pounds of rubber may be obtained from a large *Castilla* tree, though most of the latex remains in the bark. *Castilla* rubber is essentially the same as *Siphonia* rubber, but requiring different treatment, like cane sugar and beet sugar.

The idea of replacing the natural resources of wild rubber with cultivated trees was entertained much earlier in Mexico, some of the planted *Castilla* trees dating back to 1867, nearly 30 years in advance of the commercial planting of *Siphonia* in the Malay Peninsula. Thousands of acres were set with *Castilla* trees in southern Mexico near the end of the last century, before the East Indian rubber industry was developed. But Ridley's method of tapping could not be applied to *Castilla*, and the Mexican rubber plantations became a complete failure.

The differences between the two principal types of rubber trees need to be clearly understood, and also the nature of Ridley's discovery, before the problems of utilization can be approached to full advantage in tropical America. The *Siphonia* tree, because it was limited in nature to Brazil and as yet has been cultivated chiefly in the East Indies, comes to most of the American countries as a new introduction, and inevitably is viewed from the standpoint of experience with the local *Castilla* tree, which proved disappointing. *Siphonia* often appears less promising than *Castilla*, until the differences are

appreciated. In early plantings of the two trees, in Haiti and in Panama, *Siphonia* was reckoned as a complete failure, and the trees cut down, on account of the smaller flow of latex, before Ridley's method of repeated tapping of *Siphonia* became known. The secret lies in the latex tubes of *Siphonia* uniting into a network. The latex tubes of *Castilla* do not form a connected system, the flow of latex does not continue, and the *Castilla* trees are soon killed by severe tapping. Mechanical extraction is possible by harvesting the entire *Castilla* tree as a forest product, as explained in Science, April 23, 1937, but *Siphonia* is superior as a plantation tree, producing rubber in a few years and yielding regularly.

CONFUSION OF THE NAMES

The cultivated rubber tree is known to have been carried to the East Indies from the lower Amazon Valley, and often is called "the Para rubber tree," but is stated in many reference works to have been discovered in the forest of Esmeraldas on the Pacific coast of Ecuador by the French engineer-astronomer La Condamine in 1736. In reality, neither this tree nor any related species has been found in any locality west of the Andes, all the species of *Siphonia* being confined to the Amazon Valley or to the Atlantic watershed in Guiana and Venezuela.

The rubber tree of the Pacific coast district of Esmeraldas is a species of *Castilla*, like the Mexican and Central American rubber trees. The genus *Castilla* belongs to the breadfruit family, related to the fig and the Osage orange, while the Para rubber tree belongs to the spurge or euphorbia family, with the castor bean and cassava. *Castilla* is very widely distributed in tropical America, from Mexico to Brazil, had numerous uses among the natives, and furnished the early exports of rubber to Europe, not only from Mexico and Central America, but also from South America, including the Amazon Valley. The error of supposing that the Para rubber tree was discovered in Ecuador arises from the fact that the native name *heve*, relating in Ecuador to the *Castilla* tree, was carried to Guiana and erroneously used as the name of a genus, to which the Para rubber tree later was referred. The modern preponderance of the Brazilian rubber tree has left the error unrecognized.

La Condamine was the first European to foresee a commercial future for the strange elastic substance that others had passed as a curiosity. Two centuries earlier Sahagun had described the Mexican *ulli* as a very pliable resin (*resina muy correosa*) made into bouncing balls, and another century was to pass before Hancock and Goodyear

undertook its industrial development. La Condamine's interest in rubber was expressed in a report to the Royal Academy of Sciences at Paris in 1736, and led at Esmeraldas to a personal friendship with a capable young Spaniard named Maldonado, familiar with the native uses of rubber. Maldonado accompanied La Condamine on the return journey but died soon after reaching France, so that the rubber in Ecuador received no further attention.

Rubber was in demand, chiefly for candles and torches, and was being gathered in the upper Amazon Valley when La Condamine descended the river in 1743. Small objects modeled of rubber were seen at Para, and some of these were carried to French Guiana, where a search for rubber trees was started. Fresneau, an engineer who spent 14 years in this colony, found several latex-bearing trees, as reported through La Condamine to the Paris Academy in 1751. One of the Guiana trees was supposed from native information to be the kind that furnished rubber in Brazil, and this was described by Aublet in 1775 as *Hevea guianensis*. Several localities were noted, and the nuts were said to be gathered and eaten by the natives, the "almond" having a pleasant taste. La Condamine and Fresneau are not mentioned, but a reference is given to the "poor figure" of the Guiana tree in the memoir of 1751. The name "*Hevea peruviana*" engraved on Aublet's plate 335 leaves no doubt that the Guiana tree was supposed to be the same that La Condamine had found on the coast of Esmeraldas, "northwest of Quito," where *Castilla* grows, and the name *heve* was recorded.

Thus it came about that the name *heve*, used by the natives of Esmeraldas for the *Castilla* tree, was employed by Aublet as a generic designation for the Guiana rubber tree, and by later botanists it was extended to the Para rubber tree. Some writers have compromised by placing Esmeraldas in Brazil or in Venezuela, instead of in Ecuador, showing another kind of confusion that a misleading name may generate. Ducke says in a footnote of his *Revision of the Genus Hevea*, in 1935: "I do not know why Aublet attributed the origin of the name *heve* to Esmeraldas on the Pacific coast of Ecuador, where the genus Hevea is unknown." The reason is that the trees were assumed to be the same, since both produced rubber.

Aublet followed Plumier in using many native vernacular names as generic designations. Dozens of such names were adopted, some of them much alike and easily confused, as *Couepia*, *Coupoui*, *Couratari*, *Courbari*, *Couroupita*, *Coumarouna*, and *Coutoubea*. Linnaeus and his followers often rejected such vernacular names as "barbarous," but a

more serious objection may be seen in the lack of distinctive meaning, and the difficulty of remembering them as merely arbitrary collocations of letters or sounds. An authentic aboriginal name for an outstanding type, like *Mammea* for the mamey or mammee-apple of the West Indies, has meaning and historic interest, at least in its native country, but a misplaced aboriginal name, carried to a distant region and applied to a different plant, inevitably generates confusion.

SIPHONIA AN ALTERNATIVE NAME

To avoid the confusion thus inherent in the use of *Hevea* as a generic name for the cultivated rubber tree, the name *Siphonia* may be resumed, which had been the accepted name of the genus during three-quarters of a century and should have been retained. The return to *Hevea* by Mueller von Aargau in 1865 apparently was taken on grounds of priority alone, without considering that *Hevea* had been discarded as a homonym. The principle of priority, with its promise of greater stability in nomenclature, was coming into prominence in the time of Mueller, but priority alone is not a solution. It is only one of the principles that affect the utility of names. Under guise of priority many obscure names were taken up, which more careful study would have left in oblivion. The method of types, for fixing the original applications of generic names, received little attention from botanists until the last decade of the nineteenth century.

Specious arguments are made that rules of nomenclature should be set aside in dealing with names of important plants, to avoid troublesome changes. There is equal need to reflect that plants of special utility are more likely to receive historical study, and there is no assurance that "technical botany" will be appreciated for any special dispensations that would tend to confuse and obscure the early records. With the economic plants there is greater need of unequivocal names, not borrowed from other species. The taxonomic problems need to be studied with more care than has been customary, and with better appreciation of the various functions of botanical science in human welfare. Needless complications in codes of nomenclature are evidence of inadequate study. Our *International rules of botanical nomenclature* have a rather elaborate section on "Gender of Generic Names" but overlook an elementary rule of Latin grammar that has governed botanical usage, the rule that tree names and plant names take feminine adjectives, to agree with *arbor* or *herba* as an implied appositive.

The difficulties of changing names often are exaggerated, since

botanical workers are accustomed to the use of alternative names. The notion of new names being entered at once and old names summarily discarded, is found among indexers, cataloguers, or even herbarium assistants, rather than among experienced botanists, familiar with the use of names in the study of plants. The "old" names are not "wrong," unless they are given to the wrong plant. A familiar long-current name may continue for years to serve reference purposes, botanic, bibliographic, or commercial, better than a new name, unless both names can be given. The older names never are completely discarded, but remain in reference use among students of botany who have sufficient interest to follow the history of a plant to the original sources.

Changes of names necessarily are made gradually, since there is no escape under scientific methods from the fact that the acceptance of new names is determined eventually by knowledge of the plants. Like "patents applied for," new names obtain formal recognition when the descriptions are published, but general currency is not attained until other botanists have studied the plants and are convinced that the groups in reality are distinct from others previously known, or that the earlier names were not properly used. Practical tests of usage are not made unless suitable alternatives are available for names that are equivocal or confusing. A tree that has only an ambiguous, misleading name is less accessible to study.

Some of the changes of names result from new plants being discovered or mistakes corrected, while others arise from progress in classification through the discovery of new characters or relationships. It is a mistake to suppose that a completely uniform nomenclature is possible, or that a fixed system would be desirable in the present state of knowledge. All the names are provisional in the sense of requiring continued approval, and subject to change with increased knowledge. The notion of disregarding the names that were considered by their authors as provisional is one of the strange proposals in recent efforts to reform the system of nomenclature that would generate needless complications. In science as in other activities the tendency is for public interests to be treated casually, with the arguments often drifting away from the facts. The danger of science disintegrating into sterile specialties is not imaginary. Constructive reforms are needed to keep taxonomy as a part of the study of plants and to open this field of natural interest to a wider public. George Santayana's *Dialogues in Limbo* satirize botany as a trivial, overtechnical science with a peevish insistence on "the right names for flowers."

RIDLEY'S FATEFUL DISCOVERY

A more fateful discovery than Ridley's method of harvesting the rubber of the *Siphonia* tree would be difficult to adduce from the pages of history. Many "epoch-making inventions" are recounted, but none that so promptly affected so many millions of people. In all civilized countries living conditions and social relations were profoundly changed in a few years. Even among primitive tribes in remote and backward regions of the Tropics, rubber cultivation had almost immediate effects. Thousand of Malays, Hindoos, and Chinese soon were engaged as contract laborers on the rubber plantations, while other thousands of even more primitive people were released from the gathering of wild rubber in forest regions of both hemispheres, and in effect were reprieved from extinction through Ridley's discovery.

A parallel may be seen in Eli Whitney's invention of the saw gin for short-staple cotton, which had social and political significance in the rapid expansion of Negro slavery in the Southern States, eventuating in the Civil War, but these effects were relatively local, while the rubber reactions are world-wide. The ascendancy of the northern nations of Europe may be ascribed to the introduction of the potato, but centuries were required for the potato sequence to work out, while less than half a century has elapsed since the first commercial planting of the *Siphonia* tree, in 1896.

To open new sources of rubber, the tropical world of both hemispheres was being ransacked before the first plantations began to produce. Hundreds of localized rubber-bearing plants had been found, trees, shrubs, and vines, and many of these were being intensively exploited, through natives enlisted as rubber-gatherers. Although commercial and industrial advantages are reckoned from such utilization of natural resources in primitive countries, the general effect is that the native populations are rapidly disorganized, depleted, and destroyed. The older rubber and chicle districts in southern Mexico and Central America were completely depopulated, and much of the rubber country in South America. Rubber-gatherers were recruited in the coast districts of Brazil and carried hundreds of miles to the rubber forests, where thousands perished. This period of frantic rubber-gathering reached an end when plantation rubber came into the market, and lower prices were in prospect. Gruesome chapters of exploitive savagery are outlined in the book entitled *Rubber, a story of glory and greed*, by Howard and Ralph Wolf, 1936.

Rubber production offered such immediate advantages that only a few years were required for a new agricultural industry to be created in the East Indies, and new manufacturing industries in Europe and America, providing new systems of communication and transportation in all civilized countries. Rubber and gutta-percha as insulating materials made it possible for electricity to be utilized. Our highly mechanized civilization often is symbolized as "the Rubber Age." Riding on rubber has become our "standard of living." A vast extension of the human environment has taken place.

Hundreds of chemical and physical discoveries have contributed to "modern scientific progress," but rubber in thousands of tons was necessary for the endless new applications to be developed. Ridley's biological observation was the critical point in quantity production, making it possible for our industrial and cultural transformations to go forward with such amazing speed. It might be said that Ridley turned on the rubber, and caused an industrial deluge. Even our "World Wars" and our "economic chaos" may be reckoned as consequences of Ridley's discovery, from facilities of transportation and communication being increased too rapidly for social adjustments to be made. Industrial populations "demand continuous prosperity" in order to furnish regular employment. Commercial rivalry is readily intensified to savage competition and national conflict.

RIDLEY A NATURALIST

It should not detract from our appreciation of Ridley's discovery that it was made under pioneer conditions and was not reported for several years, as Ridley explained in a letter to Fairchild, published in November, 1928, in the Journal of Heredity. Only a beginning was made, and scientific interest is not competitive. Ridley was not an inventor or an intensive specialist, but a naturalist, and the rubber tree with him was one of many concurrent interests. The tapping method was discovered casually, as a simple observation of latex flowing repeatedly from the same wound, and in larger quantity, after paring the cut.

It was known from Brazil that the first tapping drew little latex and was referred to as "calling the rubber." Hatchets were used for tapping in Brazil, gashing and scarring the trees, so that the surface in a few seasons became too rough for tapping to continue. The period of production would have been too short for plantations to have been practicable under the Brazilian method of tapping. Ridley's method replaced the many gashes with a single knife-cut, thus greatly reduc-

ing the labor of tapping, avoiding injury to the bark, and extending the period of production through many years.

Caring for the rubber trees at Singapore, as superintendent of the botanic gardens, did not make Ridley directly responsible for a study of methods of tapping. The extraction of rubber was viewed officially as a physiological problem and was being investigated at a laboratory in Ceylon. Notions of professional property might have kept Ridley's volunteer interest from being exercised. It was assumed in Ceylon that the Brazilian method of tapping with many small cuts would be followed, and on that basis there could be little outlook to commercial planting.

The theory of the wound response, as inducing a greater intensity of physiological action in the bark of the tree and thus increasing the flow of latex, has been reckoned as a scientific contribution from the work in Ceylon, but in reality it was erroneous and misleading. The underlying facts were determined by later investigators, that the latex system is continuous and that a more liquid latex, with a lower content of rubber, replenishes the tubes adjacent to the tapping cut, which explains the freer flow in the subsequent tappings. By virtue of the minute latex tubes uniting into a network, the entire system drains to a single outlet. The prompt replacement of the latex and renewal of the bark pressure may be viewed as a remarkable provision of the *Siphonia* tree against the wound reactions that otherwise might occur, if the tissues were depleted or were invaded by fungi or bacteria.

Novelty is not the naturalist's primary interest, nor is he intent upon the industrial or commercial utility of any fact that he may observe. The satisfactions of the naturalist are in seeing what nature affords. "I have never got over may astonishment at this world." Not only the lands and the landscapes, the towns and the belfries, call the naturalist, but all the forms of life, that he may "feast his heart." Bates, in *The naturalist on the Amazons*, recounts his years of unabated interest: "Although now a forest rambler of ten years' experience, the beautiful forest which surrounds this settlement gave me as much enjoyment as if I had only just landed for the first time in a tropical country." "The saddest hours I ever recollect to have spent" were in leaving Brazil. "I felt that the last link which connected me with the land of so many pleasing recollections was broken."

Ridley was an explorer of the Malayan forests, but he also took account of the South American rubber trees in the Singapore Garden and became interested in the flow of latex, to the extent of making his

simple tests. He wanted to see how close the cuts could be made together and whether the flow would be affected. Different cuts were tried and gradually simplified to a sloping groove cut with a sharp gouge, with a thin layer removed every morning or at intervals of two or three days, thus obtaining a repeated flow of latex, through weeks, months, and years.

THE FIRST COMMERCIAL PLANTING

Ridley saw the bearing of his discovery, but its practical importance still had to be demonstrated by establishing rubber plantations. As Lamarck once reflected, making a fact known often is more difficult than discovering it. Although many planters were "strongly advised to turn their attention to this plant," several years passed before any individual was found with sufficient intelligence and courage to make such an experiment on a commercial scale. Fairchild says, in *The world was my garden*, that Ridley "complained of the lack of interest the British planters of the Malay States showed in this Brazilian rubber tree." How many British planters refused the distinction of pioneering the rubber industry is not stated, but in 1896, according to Ridley's report, "Mr. Tan Chay Yan was induced by the Director of the Botanic Gardens to plant rubber." The discovery might easily have miscarried and been forgotten. An accident to Ridley or to Yan might have turned the scale. There was only this "Chinaman's chance" of rubber being planted. To Ridley it seemed in order that the Gardens be used and appreciated, but not that he should turn aside from botany and make a million out of rubber. "Reward as such has nothing to do with the essential act of creating."

False impressions are conveyed by much that is written to advocate science. Special states of mind are supposed to be needed for making important discoveries. "Scientific discovery almost always depends upon a man's looking at something in the dry light of the intellect and isolating himself from the previous thoughts both of himself and other men about it." Forced abstraction, "supreme attention to one thing," may be a mental environment for logical analysis of formal problems but is no substitute for the naturalist's interest. "No remarkable discovery is in the power of anyone." Ridley's discovery was an accident, but one that could not occur without the trees at hand, and the attentive mind.

Nobody at that time had the idea of a rubber tree with a continuous latex system, that would provide a repeated flow of rubber milk by shaving the margin of the same wound every day or on alternate days.

Such a notion of rubber production would have seemed too fantastic to be credited, until it took body as a fact, after Ridley's discovery and demonstration. Goethe says that we see only what we know, but with each advance of knowledge somebody must see what has not been known, or even expected. This is the creative vision, to see things as they actually are, and to lay aside our former limitations. The expansion of the rubber industry, after the first plantation had succeeded, was so immediate and overwhelming that Ridley's discovery was generally overlooked and might have remained in oblivion if Fairchild's record had not been published.

The need for naturalists now seems greater than ever, on account of our present civilization being so badly overbalanced on the mechanical and industrial sides, even in the study of the biological sciences. Researches may be conducted in formal lines and elaborately recorded by men who are not naturalists, take little notice of outlying facts, and frame their structures of knowledge as closed systems. A misleading emphasis often is placed on logical or statistical analysis of facts that have been reduced to formal records, but without the naturalist's interest in the wider relations. The nature and extent of Ridley's interest may be followed in his many papers and books on the flora of the Malay region and in his massive work on *The dispersal of plants throughout the world*, published in 1930, a general treatise on the adaptive characters that determine the dissemination of plants. A review of his botanical work appeared in Nature for March 21, 1936, occasioned by his eightieth birthday, December 10, 1935.

Sending the tree abroad to let naturalists study it doubtless would have seemed a fantastic proposal. Progress is contingent on bringing the naturalists and the trees together. Brazil and other neighboring regions may be advantaged in the end from the knowledge obtained in foreign countries. Several eminent naturalists, as Martius, Wallace, Bates, and Spruce, spent many years in Brazil, but there the rubber trees are immersed with thousands of other species in the vast Amazonian forest, and detailed study is out of the question. Not until the trees are grown separately do their characters and habits become known. Even botanical specimens of the forest trees are seldom obtained, except as a good marksman may shoot down twigs or small branches with a rifle. The forest canopy of the tropical world is less explored than the polar ice-caps. Doubtless some botanical Byrd will rig a dirigible with a barge of canvas or wire netting that will rest on the roof of the forest and allow the treetops to be visited.

The chief discovery in South America regarding *Siphonia* is the

leaf disease caused by the fungus *Dothidella ulei*, or *Melanopsammopsis ulei*. This disease is a serious obstacle to open planting of *Siphonia* in Brazil, on account of many fatalities in the seedlings and juvenile stages, but Ridley's method of tapping is being applied to trees of natural growth in the forests, and systems of permanent production may be developed, instead of rubber districts producing for only a few years. Commercial interests suffered when the sending of rubber-gatherers into the remote forests became unprofitable, but with regular production of rubber settled populations may be established in many of the rubber districts, and Brazil again may become the principal source of rubber.

OTHER VERNACULAR NAMES

The primitive people who inhabited the forested regions of tropical America lived in small, widely separated groups, each tribe with its own language and with different names for most of the natural products. The rubber of the *Castilla* tree had the name *cauchuc* in the language of the Incas, now called Quichua. The French spelling is *caoutchouc*, and the modern Spanish form is *caucho*, the word that still is used as the name of *Castilla* rubber, not only in Ecuador and Peru, but also in Brazil. *Castilla* as well as *Siphonia* existed in all the rubber areas of the Amazon Valley, and caucho rubber still is exported in commercial quantities, especially where new districts are being opened.

The name *caucho* is not applied in South America to the rubber of the *Siphonia* tree, but a Portuguese name *borracha*, meaning *bottle* in the original sense of a leather wine-skin. Some of the tribes along the Amazon knew how to make bottles and squirt-guns by spreading the latex over an earthen mold, curing the rubber in the smoke of palm-nuts, then crumbling and washing out the earthen material. Some writers have supposed that the *Siphonia* tree was called *syringa* by the Portuguese colonists because syringes as well as bottles were made of the latex, but a simpler explanation may be that the flowers are clustered like lilacs and have the same fragrance. The men who gather the *Siphonia* rubber are called *seringueiros*, while the *caucheros* are those who collect the *Castilla* rubber, a different occupation.

The Aztec name for *Castilla* rubber, *ule* or *hule*, was recorded by a Spanish historian, Sahagun, who arrived in Mexico in 1529, more than two centuries before La Condamine reached South America. In the seventeenth century another Spanish writer, Cobo, recorded the Peruvian name *cauchuc*, and identified it with the *ule* of Mexico,

"which is well known in all the Indies." The leaves, branches, and fruits of the tree are described to an extent that leaves no doubt of it being *Castilla*. Cobo's book, *Historia del Mundo Nuevo*, written in 1653, was published in Seville in 1891. No warrant has been found for a statement in a recent textbook of economic botany that the name *cahuchu* was derived from "primitive Central American Indians." Many other names, as *sheve*, *sabac*, *sabbe*, *zini*, *sini*, and *seru*, are recorded in Lehmann's *Zentral Amerika* as equivalents of *ule* or *caucho* in native languages of Ecuador, Colombia, Panama, Costa Rica, and Nicaragua. The *tunu* or bark-cloth tree of the Mosquito coast is a species of *Castilla*, said to produce only inferior rubber.

Rubber from some of the "West coast" districts still is called *jebe* as a trade name. The word is defined in several Spanish dictionaries as *caucho* or *goma elastica*, indicating that the two words were separately adopted from different native languages of "Peru" in the colonial period. At the beginning of the nineteenth century Humboldt and Bonpland reported the name *caoutchouc* as associated in Colombia with two species of *Ficus*, and with a species of *Lobelia* growing as a tree 20 to 30 feet tall, at altitudes of 6,000 to 9,000 feet, in the mountains around Popayan.

TREATMENT OF HOMONYMS

The name *Siphonia* was substituted for *Hevea* by Lamarck on plate 790 of the *Encyclopédie*, but the illustrations did not appear till 1798, The change was noted in the second volume of the Supplement. published in 1812, but the volume with *Siphonia* in alphabetic sequence was delayed to 1817. The publication of *Siphonia* usually is dated from Schreber's *Genera plantarum*, 1791, where the name is credited to Richard, who probably suggested it to Lamarck. Willdenow, in 1805, seems to have been the first author to publish a species under *Siphonia*, with Richard as the author of the specific name, *Siphonia cahuchu*, and *Hevea guianensis* Aublet as a synonym.

Another generic substitute, *Caoutchoua*, was proposed by Gmelin in the same year with Schrader's publication of *Siphonia*, 1791, and was accompanied by a specific name, *Caoutchoua elastica*. Thus *Caoutchoua* appears as technically established 14 years before *Siphonia* was equipped with a species by Willdenow. Rules of nomenclature, strictly interpreted, would require this name *Coautchoua* to be used, with the type species as *Caoutchoua guianensis* (Aublet), a new combination.

The underlying objection to *Caoutchoua* being accepted instead of

Siphonia is the same as against *Hevea*—the confusion inherent in the fact that the vernacular name *cauchuc* or *caoutchouc* related originally to the *Castilla* tree and was not properly available as a name for the *Siphonia* tree of the Amazon Valley. Misplacement of vernacular names in scientific terminology obviously is unwarranted, and doubtless will be condemned in codes of nomenclature. If botany stood entirely alone, arbitrary borrowing of vernacular names conceivably might be tolerated, but for botanical terminology to remain permanently at variance with the neighboring sciences, as philology, ethnology, and pharmacology, is scarcely thinkable.

Formerly it was considered that homonyms might be revived where the earlier use of a name had proved invalid. Thus in DeCandolle's *Prodromus* the name *Evea* Aublet was placed as a synonym of *Cephalaeis*, and this may have been supposed to allow the revival of *Hevea*, but later writers have treated *Evea* as a distinct genus. The instability of names resulting from such variations of opinion among taxonomists resulted in the rule against homonyms being revived, after once being discarded. There is nothing to indicate that Mueller took account of the early history of *Hevea* or of the objection to homonyms being restored.

If the names are not words to be spoken, but only graphic symbols to be copied on labels and catalogue cards, the difference of a silent letter may seem sufficient, since it gives a visible difference, if not vocable. The earlier botanists undoubtedly thought of speaking the names, so that homonyms quite definitely included homophones. Thus it is possible to object that the names were not identical, and that substitution of *Siphonia* for *Hevea* was not warranted, but the fact remains that the change actually was made and was generally adopted, and that such rejections of names have been considered as irreversible, under rules of nomenclature. "Once a homonym always a synonym." No object is gained by going back to a doubtful or debatable name, once it has been challenged and discarded as causing confusion. Treating one name as dependent on variable opinion regarding the availability of another name obviously conflicts with the primary need of stability in nomenclature.

MISLEADING NAMES FOR THE SPECIES

The name *brasiliensis*, generally associated with the cultivated rubber tree, was borrowed from a related species, not found in the lower Amazon Valley but on the southern frontier of Venezuela, along the streams that connect the head waters of the Orinoco and the Rio

Negro, a region explored in 1800 by Humboldt and Bonpland. The description of the tree was published by Humboldt, Bonpland, and Kunth under the name *Siphonia brasiliensis* in 1825, in the last volume of the monumental work on the plants of Humboldt's travels in tropical America, *Nova genera et species plantarum* **7**: 170. Two localities were reported and two native names, *jacio* for the tree and *dapiche* for the white rubber, "*caoutchouc album*," said to adhere to the roots, presumably as exposed on the banks of the rivers. Pittier has *jacia* as a native name in Venezuela, but not *dapiche*.

The name *brasiliensis* seems to have been occasioned by the Humboldt specimen being compared by Kunth with a specimen in the Willdenow herbarium, to which the name *Siphonia brasiliensis* had been attached, but without being published. It is hardly to be maintained that the use of this name by Kunth constituted a publication of the Willdenow species. A name is not authenticated by being mentioned in synonymy or by being printed with a description of a different species. Instead of basing his description on the Willdenow plant, Kunth stated in a footnote that the Willdenow specimen had smaller leaves, paler underneath.

The normal assumption would be that the name belongs to the Humboldt species, the association that is recognized in the *Index Kewensis* and other reference works. Since Brazil at that time was a geographic expression rather than a political entity, the name *brasiliensis* would not have appeared inappropriate for any tree from the vast central forest of South America. The proposal of Baillon in 1858 that the Humboldt tree be assigned a different name, *Siphonia kunthiana*, would avoid for this species the confusion involved in the name *brasiliensis*, but for the cultivated rubber tree the name *brasiliensis* would still be ambiguous, leading back inevitably to the Humboldt rubber tree and to the long confusion of the two species. Lamarck recognized in 1789 that the rubber tree of the lower Amazon was different from Aublet's Guiana species, but the Humboldt tree was accepted by many writers as the source of commercial rubber. Even in Mueller's critical revisions of the group in DeCandolle's *Prodromus*, 1866, and *Flora Brasiliensis*, 1874, the two species were not separated, Baillon's *Siphonia kunthiana* being placed as a synonym of "*Hevea brasiliensis* Muell. Arg." No specimens of the fruits or the seeds were seen by Mueller.

Owing doubtless to the confusion of the two species, no detailed account of the lower Amazon rubber tree was furnished, but in 1874 a description was drawn from specimens grown at Rio Janeiro, which

Mueller did not recognize as the Para rubber tree, and published as a new species under the name *Hevea janeirensis*. This name may be transferred to *Siphonia* as a new combination, *Siphonia janeirensis*, but using this name for the cultivated rubber tree would create more confusion, as if a Florida plant that happened to be grown in Canada were named *canadensis*. The case is parallel to the use of *Asclepias syriaca* as the name of our New England milkweed, and *Simmondsia chinensis* for the jojoba nut of southern California and Arizona, plants not native in Syria or in China or having any relation to those countries except as specimens were wrongly labeled. The use of such names, admittedly erroneous and misleading, marks a phase of professionalism among herbarium workers that doubtless will prove temporary.

For filing pressed specimens in herbaria, one name may serve as well as another, but in field and garden studies these misleading names are a permanent handicap, requiring always to be "corrected" and explained anew to each generation of botanists and plantsmen. If the name *Siphonia janeirensis* were used, all future generations of botanists and writers on rubber would need to be cautioned and checked against the natural assumption of a native rubber tree at Rio Janeiro in southern Brazil, hundreds of miles beyond the natural range of distribution of the species, or of other members of the genus. The name in itself is of little moment, but avoiding confusion is important. In writing *Siphonia ridleyana* we acknowledge our debt to Ridley and also admit the need of more care in naming plants.

A RIVERINE HYBRID

An extreme variability of the cultivated rubber tree may be connected with the biological status of the wild stock in South America. Because of the geographic position of the species in the lower Amazon Valley and the adaptation of the seeds for floating, unusual conditions for hybridization are afforded, not as a rare contingency but as a normal occurrence. Swollen currents from the upper river often reverse the flow of the lower tributaries, so that floating seeds may be stranded far from the main channel. Thus the stock of *Siphonia* over a wide area of the lower valley must have remained continually accessible to crossing with the several up-river species. Hybridizing as a preliminary to selection has been accomplished in nature.

The range of variation in *Siphonia ridleyana* may be found to include all the characters of the other species, when these are definitely known, and with endless abnormalities appearing among the seed-

lings, beyond the range of the parental types, comparable to the extra-parental diversities shown in perjugate hybrids between different species of cotton, as described and illustrated in the Journal of Heredity for February, 1915. The same problem is presented, of finding among the infinite wrack of degenerating forms any lines of descent with desirable characters in stable patterns, "coming true" from seed. High-yielding types are being utilized by budding, but are only a partial solution of the trading problem. Uniform seed-stocks would be much more valuable. Comparing progenies of tree-crops in order to determine uniformity is an experimental undertaking of vast proportions, in which all the rubber-growing countries might well cooperate.

The diversity in the cultivated stock of *Siphonia* is comparable with that of some of our animals and plants that have been domesticated for long periods, as cattle, horses, dogs, wheat, cucurbits, and potatoes. The range of characters in these long-domesticated groups is supposed not to have been derived from a single wild stock but from several related species developed in different regions, but brought together and mongrelized in primitive times. Diversity is found among the members of all the wild species of plants and of animals that are studied carefully, but usually the diversity is less than in the cultivated stock of *Siphonia*. Other species are considered in Ducke's *Revision* to be as variable as "*brasiliensis*," and this would be expected of any stocks similarly exposed to crossing.

The trees are found to differ not only in the stature and growth of the trees, the leaves, floral characters, and seeds, but also in the bark texture and in the latex tubes, which determine the yield of rubber. The surface of the bark may be smooth or finely wrinkled like a beech tree, or rough and rimose like an elm or an oak, while the texture may be uniform, soft and cheesy, or brittle and gritty with stone-cells. Records show some trees yielding scarcely any rubber, and others only small amounts, with a few far above the general average, so that 75 per cent of the rubber is produced by 15 to 25 per cent of the trees. Budding from high-yielding trees raises the average, although yields vary as before, on account of diversity of the stocks.

To exhibit the diversity of leaf-forms many illustrations would be required. A single example is given in Fig. 1, showing in natural size two slender leaves from an abnormal plant, compared with a normal leaf. The closer and more numerous primary veins of the abnormal pinnae should be noted, as well as the narrow outlines and crenate margins. Many variations have still narrower pinnae, and the margins notched to the midrib, while others have curved or twisted pinnae,

Fig. 1.—*Siphonia ridleyana*, a normal leaf overlain by two abnormal leaves. Natural size.

or funnel-shaped "ascidia." The series of foliar aberrations is comparable to that of the familiar "crotons" or codiaeums, which also belong to the spurge family.

Pinnae of normal form are only two or three times as long as wide, while some of the abnormal pinnae are 10 times as long as wide, or even 20 times as long. Most of the extreme mutants are outgrown by the normal plants and smothered in the seedbeds, or not transplanted from the nurseries, but a mature narrow-leaved tree, with flowers and fruit, was found in Haiti. The pinnae were slender and tapering, similar to those of the photograph, though not elongate. Some abnormal plants have the stalks of the pinnae longer than usual, or the stalks may be very short and grown together, so that the pinnae do not separate. Leaves with supernumerary pinnae, 4, 5, or 6, are found on trees otherwise normal.

Heavier texture of the foliage may be a factor of resistance to the South American leaf disease, and earlier attainment of the adult foliage is a character to be regarded in selection. Plantations of *Siphonia* are difficult to establish in Brazil and other American countries infested with the leaf disease because many young trees are defoliated and killed. The juvenile stage is specialized, the branches suppressed and the foliage more delicate, adapted to shade conditions in the undergrowth of the forest, as explained in Science.[3]

SIPHONIA ADAPTED TO SMALL FARMING

The system of large plantations operated by contract labor, as practiced in the oriental countries, may not be feasible in tropical America, but other modes of production may be developed that do not require large undertakings. The momentum of a vast industry makes it difficult to think of planting trees in hundreds instead of thousands. In reality the *Siphonia* tree, under the Ridley method of tapping, is as well suited to small independent producers as to large estates, thus avoiding the "overhead" expenses that often absorb more than half the outlay in opening plantations. All the tropical American countries are users of rubber, and all may become regular producers. First efforts in new districts may fail because the seeds are short-lived and the seedlings rather delicate, but once the trees are established they are likely to become a permanent resource. Where beginnings are assisted and seeds or budded stocks are available, the trees can be grown among other crops with little labor or expense, merely replac-

[3] Science 71: 386–387. 1930.

ing some of the nonproductive trees that often serve in tropical gardens or orchards for shade or wind protection.

Castilla often has been used as a shade tree, but a regular yield of rubber is not obtainable. Because the *Castilla* latex flows freely at the first tapping, there is much more danger of the rubber being stolen and the trees killed or permanently injured by marauders. More labor is required to harvest the rubber of *Siphonia*, but production is regular. Even a hundred *Siphonia* trees, the planting quota of a single acre, may engage the interest of self-supporting families in all the countries where the tropical tree-crops are grown, notably coffee and cacao, where avocados, papayas, guavas, or citrus fruits are grown, as in southern Florida. The rubber trees would be tapped every second or third day, requiring an hour of labor and affording a return of a dollar or more from each hundred trees. The work is light and clean and is done in the cool of the morning.

Experiments in southern Florida, near Coconut Grove, indicate that *Siphonia* and other tropical rubber trees, as *Castilla*, *Funtumia*, and *Manihot*, are adapted to the local conditions, flowering and seeding abundantly. Rubber produced by *Siphonia* trees in Florida has been tested by the National Bureau of Standards, and excellent quality found. Popular interest may lead to general planting of *Siphonia* and the other rubber-bearing types in southern Florida, at least as garden trees, and with fresh latex at hand new uses of rubber or improved manufacturing processes may be worked out. The stocks may be improved by selective breeding and through survival of the hardier trees in periods of unusual cold. Hardier strains developed in Florida might be of use in Mexico and in many other countries. The extent of tolerance of low temperatures or other unfavorable conditions is still to be determined. Apart from any question of producing commercial quantities of rubber in Florida, the information and experience that would be gained by planting rubber trees in different localities in Florida might be of great value in extending the range of rubber planting among resident populations in tropical America.

The limitation of the genus *Siphonia* to the Amazon Valley and the eastern slopes of the Andes carries no implication that planted trees will not thrive in the Pacific belt of Ecuador and Colombia and in other parts of tropical America, as they have in Asia and Africa. The natural distribution of the South American leaf disease is still unknown. It has not been found in Haiti or in Florida, and it may be absent from other islands or parts of the mainland, although it has appeared in Dutch Guiana, Trinidad, and Costa Rica.

HERPETOLOGY.—*A critical synopsis of the Mexican lizards of the* Uta ornata *complex and a description of a new species from Chihuahua.*[1] M. B. MITTLEMAN, Ohio University, Athens, Ohio. (Communicated by LEONHARD STEJNEGER.)

Since Schmidt (1921) published his brief paper containing diagnoses of new forms and a key to the entire genus, no one paper has appeared dealing with the Utas as a cohesive whole, or in entirety. Neither has any paper dealt with all the forms within any one group of the genus. Smith (1935) published the description of a new species (*Uta caerulea*) from Mexico and included in his paper some notes on certain other Mexican Utas, which up to that time had been largely neglected in the literature. In his lengthy work on the reptiles of western North America, Van Denburgh (1922) treated only those forms coming within the scope of his studies, namely, the species and subspecies occurring in the United States, extreme northern Mexico, Baja California, and the islands within the Gulf of California. The notes and diagnoses herein deal with the Mexican representatives of the *Uta ornata* complex and are offered until a longer paper dealing with the entire complex is published.[2]

Uta ornata lateralis Boulenger Figs. 1A, 2

Uta (*Phymatolepis*) *lateralis* Boulenger, Ann. Mag. Nat. Hist. (ser. 5) 11: 342. 1883.

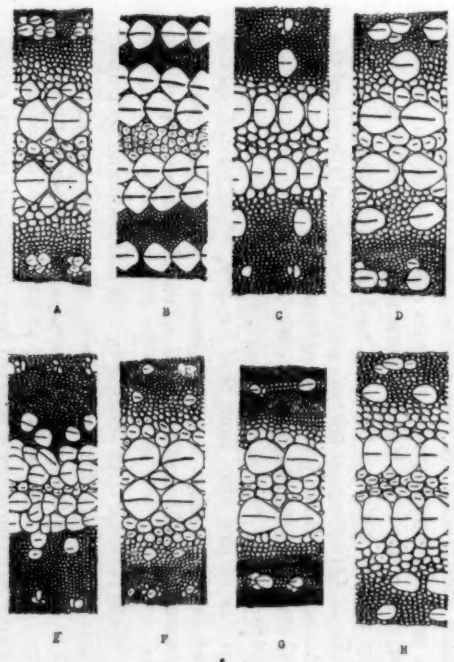
Type locality.—Tres Marias Islands and Presidio de Mazatlán, Sinaloa.

Cotypes.—BMNH 81.10.91–4 and 82.12.5.2.

Diagnosis.—One to three vertebral rows of enlarged, imbricate, carinated, irregularly arranged scales, extending from the nape of the neck onto the base of the tail for a distance equal to slightly more than half the length of the femur; bordered on either side by one, and then two series of enlarged, prominently carinated, imbricate, regularly arranged scales, those of the inner series being approximately twice as large or larger, than those of the outer series; largest of the dorsal scales superior in size to the largest of the enlarged, carinated scales of the femur and tibia; two or three elongated series of thoracic tubercles; a dorsolateral series of enlarged, mucronate, and tubercular scales, extending from the supra-axillary or thoracic region to the

[1] Received November 22, 1940.

[2] For the loan of comparative material, much useful information, and innumerable other courtesies, I express my gratitude and obligation to: Drs. Leonhard Stejneger, Alexander Wetmore, and Doris M. Cochran, of the United States National Museum; Dr. G. K. Noble and Charles M. Bogert, of the American Museum of Natural History; Joseph R. Slevin, of the California Academy of Sciences; Dr. Angus M. Woodbury, of the University of Utah; Dr. Howard K. Gloyd, of the Chicago Academy of Sciences; Dr. Edward H. Taylor, of the University of Kansas; Dr. Hobart M. Smith; H. W. Parker, Esq., of the British Museum; Karl P. Schmidt, of the Field Museum of Natural History; Dr. Thomas Barbour and Benjamin Shreve, of the Museum of Comparative Zoology; and Dr. E. Raymond Hall, of the Museum of Vertebrate Zoology. I am especially indebted to Dr. Herschel T. Gier, of Ohio University, who has been a constant source of advice and inspiration. Contribution No. 19 from the Department of Zoology, Ohio University, Athens, Ohio.



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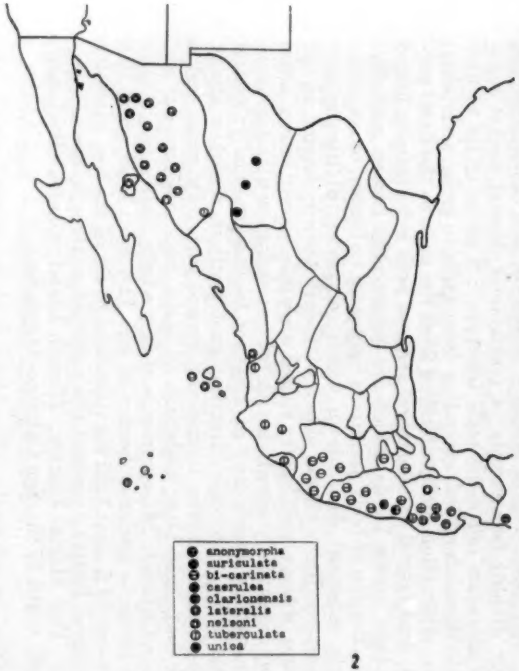

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Fig. 1.—Characteristic enlarged dorsal scales of the several Mexican species of the *Uta ornata* complex: A, *Uta ornata lateralis* Boulenger, topotype, M.C.Z. no. 22467, male, Maria Magdalena Island, Mexico. B, *Uta clarionensis* Townsend, type, U.S.N.M. no. 15904, male, Clarion Island, Revillagigedo Archipelago, Mexico. C, *Uta unica*, sp. nov., type, U.S.N.M. no. 14248, female, Chihuahua, Mexico. D, *Uta bi-carinata tuberculata* Schmidt, M.C.Z. no. 37856, male, Guirocabo, 20 miles southeast of Alamos, Sonora, Mexico. E, *Uta auriculata* Cope, type, U.S.N.M. no. 7027, female, Socorro Island, Revillagigedo Archipelago, Mexico. F, *Uta bi-carinata anonymorpha* Mittleman, type, U.S.N.M. no. 46988, male, Tehuantepec, Oaxaca, Mexico. G, *Uta bi-carinata bi-carinata* (Duméril), U.S.N.M. no. 20180, male, Cuernavaca, Morelos, Mexico. H, *Uta bi-carinata nelsoni* Schmidt, type, U.S.N.M. no. 46836, male, Cuicatlán, Oaxaca, Mexico.

Fig. 2.—Distribution of the *Uta ornata* complex in Mexico.

basal portion of the tail; several lateral series of enlarged, granular, spinose scales; ventrals abruptly differentiated from the scales of the lateral areas; scales of belly and gular region strongly imbricate and submucronate; frontal typically divided transversely; a postfemoral dermal pocket regularly present. Coloration (alcoholic male topotype): A series of six to nine dark spots on the dorsolateral line extending from axilla to groin; a vertebral series of smaller, alternating spots extending from the nape to the basal portion of the tail; dorsolateral and vertebral spots of both sides usually joined by undulating light brown bands, which are occasionally broken medially; general dorsal coloration of body and limbs light gray or brown, or occasionally a uniformly rufescent dark brown which completely obliterates any semblance of pattern; limbs barred above with dark brown; dorsum of tail similar to dorsum of body, and lightly ringed with pale brown; lateral areas a light blue-gray, irregularly streaked with brown; abdomen with two elongate, light blue patches which may or may not be fused medially; rostral and supralabials white, this color extending posteriorly in a narrow streak to the insertion of the fore limbs; infralabials flecked with gray; gular region anterior to the fold, light blue; underside of limbs, tail, interhumeral and interfemoral areas, whitish. Measurements of fifty adults, both sexes, insular and mainland: Snout to posterior border of ear, 12.6 mm; head width, 9.6 mm; snout to vent, 49.5 mm; hind leg (insertion to tip of 4th toe, exclusive of nail), 35.90 (these figures represent the weighted arithmetic means).

Distribution.—Tres Marias Islands; Tiburon Island; Sinaloa (Boulenger, *loc. cit.*); Sonora, south of the line Caborca–Magdalena.

Remarks.—Although my findings concerning the intergradation of *lateralis* and *linearis* (of southern Arizona) agree in substance with those of Van Denburgh (1922, p. 199), I have not been able to detect any signs of that intergradation in several hundred specimens from extreme southern Arizona as he did. I find, rather, that this intergradation occurs in the belt bordered on the north by the line Reforma–Cananea, and on the south by the line Caborca–Magdalena. Quite typical *lateralis* are taken regularly south of the Caborca–Magdalena line. Boulenger's record (*loc. cit.*) for the subspecies from Presidio de Mazatlan, Sinaloa, may be open to question on the grounds that Taylor and Smith, as well as other workers have failed to take any additional specimens of this form from that locality, while related species have been taken in the vicinity. Indeed, *lateralis* is known from no state except Sonora; extensive field studies should reveal this lizard in northern Sinaloa, at least.

Comparisons made between large series of insular and mainland specimens reveal only slight mensural differences, which are neither constant nor marked enough to warrant a subspecific distinction being made between the two populations.

U. o. lateralis may be quite easily separated from *linearis* on several scores. In the former, the enlarged dorsals commence well craniad of a line joining the anterior points of insertion of the fore limbs; in the latter race, these commence either slightly craniad of a line such as this, or else distinctly caudad of it. In *lateralis* the scales of the inner series of enlarged dorsals are

at least twice the size of the scales of the outer series; *lateralis* also possesses a prominent dorsolateral series of spots. *U. o. linearis* possesses no regular, distinct series of dorsolateral spots, nor is there a very appreciable difference in size between the scales of the outer and inner series of enlarged dorsals.

Uta auriculata Cope Figs. 1C, 2

Uta auriculata Cope, Proc. Boston Soc. Nat. Hist., **14**: 303. 1871.

Type locality.—Socorro Island, Revillagigedo Archipelago.

Type.—U. S. N. M. no. 7027.

Diagnosis.—Unique among the members of the *ornata* complex in possessing the enlarged femoral scales uncarinated; two vertebral rows of small, enlarged scales, these weakly carinated, imbricate, and fairly regularly disposed; bordered on each side by a single series of enlarged, imbricate, weakly carinated, rather flat scales, which are about twice as large as those of the vertebral series; a few scattered, slightly enlarged scales on the dorsolateral line; frontal transversely divided; postfemoral dermal pocket probably present (type in too poor a condition to accurately determine this); general appearance not all rugose. Cope (*loc. cit.*) describes *auriculata* as having a row of spots on the dorsolateral line, on a blue ground color. Measurements of type: Snout to posterior border of ear, 17.0 mm; head width, 11.5 mm; snout to anus, 75.0 mm; hind leg (insertion to tip of 4th toe, exclusive of nail, 49 mm.

Distribution.—Restricted to the type locality.

Remarks.—Of this species, I have examined only the type specimen. As far as this specimen goes, it is quite distinct from other known members of the genus.

Uta clarionensis Townsend Figs. 1B, 2

Uta clarionensis Townsend, Proc. U. S. Nat. Mus. **13**: 143. 1890.

Type locality.—Clarion Island, Revillagigedo Archipelago.

Type.—U. S. N. M. no. 15904.

Diagnosis.—Enlarged vertebral scales distinctly carinated, in two irregular series commencing on the nape of the neck and extending posteriorly onto the base of the tail for a short distance; bordered on either side by two series of enlarged, strongly carinated, imbricate scales, which are larger than the vertebrals, and of which the scales of the outer series are smaller than those of the inner series; scales on thighs enlarged and prominently carinated; dorsolateral tubercles and spinose scales well developed, and in clusters, forming an almost unbroken ridge; frontal transversely divided; postfemoral dermal pocket absent. Measurements of type: Snout to anus, 53 mm; hind leg (insertion to tip of 4th toe, exclusive of nail), 41.0 mm; snout to posterior border of ear, 14.0 mm; head width, 10.0 mm.

Distribution.—Restricted to the type locality.

Remarks.—Because of its closer affinity to *lateralis* than to the neighboring *auriculata*, *clarionensis* presents several important and interesting phylogenetic features. These will be later discussed under the phylogeny of the several forms.

Uta bi-carinata bi-carinata (Duméril) Figs. 1F, 2

Phymatolepis bi-carinatus Duméril, Arch. Mus. Hist. Nat. Paris **8**: 549, pl. 23, figs. 2, 2a, 2b. 1856.

Type locality.—"Mexico."

Type.—Not designated; if in existence, probably in the Muséum d'Histoire Naturelle de Paris.

Diagnosis.—Two or three vertebral series of enlarged, imbricate, weakly to prominently carinated scales, extending in a continuous or a broken line from the nape of the neck or the shoulders to the basal portion of tail, on which it continues for a distance subequal to the length of the femur; external to the vertebral series and bordering them on each side, is a single series of greatly enlarged, strongly carinated, imbricate scales which are occasionally unequal in size, irregular of arrangement, and frequently interrupted; the largest of the dorsal scales smaller than the largest of the femoral and tibial scales, which are imbricate and strongly carinated; external to the enlarged dorsals, which border the vertebrals, there is on each side a series of enlarged scales almost equaling them in size and rugosity; these sometimes in contact with the enlarged dorsals, but more often separated by two to four of the granular, convex scales of the back; these enlarged scales are also irregular in size and disposition, often commencing anterior to the enlarged dorsals; two or three enlongated series of enlarged tubercles on the neck; a prominent series of enlarged, spinose scales on the dorsolateral line, and ventral to these are four more, somewhat less prominent series, the lowest of which is in contact with the ventrals; ventrals mucronate, and occasionally somewhat spinose; as they progress laterally there is a slight tendency towards carination, which becomes most noticeable in the lateral scales; scales of the chin granular and pavemented medially and laterally; elongated, flattened, spinose and imbricate posteriorly; frontal variable, but most often entire; a postfemoral dermal pocket usually absent, but sometimes rudimentarily present. Coloration (alcoholic male): Grayish ground color on dorsum of body, head, limbs and tail; body dorsum with four or five dark cross bands, which may or may not be visible, due to an occasional suffusion of dark pigment throughout the skin, these bands often being broken medially; entire forsum of body and limbs often flecked with dark gray, pale gray, or brown; lateral areas of body usually similar in color to dorsum, but more often tinted with a bluish wash; venter of limbs, interhumeral and interfemoral areas, of varying shades of gray, and often heavily mottled with brown; ventrally, the basal portion of the tail a light gray, occasionally spotted with dark brown; a broad blue patch on the belly, which is slightly more intense anteriorly, and which may or may not be overlaid with a heavy stippling of gray or brown; except for an occasionally light medial area, the entire chin, including the infralabials, is heavily mottled with black or brown. Smith (1935, p. 170), reporting on freshly collected specimens says "the entire gular region is orange, coarsely reticulated or diagonally barred with black except in a large, round median area just anterior to the gular fold." Measurements of fifty adults, both sexes: Snout to posterior edge of the ear, 12.5 mm; head width, 10.6 mm; snout to anus, 52.5 mm; hind leg (insertion to tip of 4th toe, exclusive of nail), 29.6 mm (these figures represent the weighted arithmetic means).

Distribution.—Michoacán, Morelos, Puebla, and Guerrero west of Acapulco.

Remarks.—Much of the confusion surrounding the status of this form is

undoubtedly due to the fact that Duméril designated simply "Mexico" as the type locality for his species, and this only through inference. Consequently, the several authors who have had occasion to deal with *bi-carinata* and its affiliates, especially prior to the separation by Schmidt (1921) of the then composite species, have cluttered the literature with erroneous locality records based on misidentified specimens. Both Schmidt (*op. cit.*) and Smith (1935) have contributed to the clarification of the status of *bi-carinata*, and to these authors credit is largely due for bringing a measure of order to the state of chaos.

The Utas from the southern periphery of the range of *bi-carinata*, notably from a point just southeast of Acapulco and extending through Guerrero to Tierra Colorada, exhibit certain tendencies which are not in accord with the attributes to be noted in more northerly examples. As the population continues in the direction of the Oaxacan border this trend becomes more noticeable, so that in eastern Guerrero and Oaxaca, the lizards can no longer be considered identical with their more northerly relatives, and clearly possess the status of a separate biological entity. Since the population from Michoacan, Puebla, Morelos, and western Guerrero more closely fits the original description than does the southern form, I have retained the name *bi-carinata* for it, and described the southern population as a distinct subspecies.

Uta bi-carinata anonymorpha Mittleman Figs. 1G, 2

Uta anonymorpha Mittleman, Herpetologica II, 2: 34, pl. 3, fig. 2. 1940.

Type locality.—Tehuantepec, Oaxaca.

Type.—U. S. N. M. no. 46988.

Diagnosis.—Enlarged vertebral series of scales and the scales external to them, which are larger in size, commencing on the shoulders only slightly craniad of a line joining the anterior points of insertion of the fore limbs; enlarged dorsals in a continuous series or but barely encroached upon by a few of the small, granular scales of the back; enlarged dorsals regularly arranged and not too strongly carinated; external to the enlarged dorsals is a sparse series of enlarged scales, a trifle larger in size than the scales of the vertebral series, but never approaching size the larger enlarged dorsals; this outermost series of enlarged scales never in contact with the primary series of enlarged scales, but in contact at several points with the rather sparse and poorly developed tubercular and submucronate scales of the dorsolateral line through the medium of small, elongated clusters of slightly enlarged, granular scales; thoracic tubercles not well developed and not too prominent; dorsolateral and lateral tubercles often not well developed, and often not in clusters, but consisting rather of a single enlarged, spinose, tubercular scale surrounded by two or three somewhat enlarged, mucronate scales; ventrals mucronate and spinose, especially posteriorly; laterally these become distinctly carinated and quite prominently pavemented; scales of the chin small, rather flat, and generally pavemented, only those scales immediately anterior to the gular fold becoming elongated, imbricate, and somewhat spinose; general appearance not very rugose. Coloration (alcoholic male holotype): Quite similar to that of *bi-carinata*, save that the ventral blue (or blue-black) patches are very abbreviated, and restricted to the pectoral area;

chin usually not as heavily maculated as in *bi-carinata;* occasional specimens are uniformly suffused with a deep blue-gray which completely obliterates any dorsal traces of pattern. Measurements of holotype: Snout to posterior border of ear, 11.5 mm; head width, 9.0 mm; snout to anus, 50.0 mm; hind leg (insertion to tip of 4th toe, exclusive of nail), 27.0 mm.

Distribution.—Guerrero, east of Tierra Colorada; Oaxaca, except the northeastern corner; eastern Chiapas (Tonolá).

Remarks.—I have previously postulated (*loc. cit.*) on the possibility of a subspecific relationship existing between *bi-carinata* and *anonymorpha.* Through the kindness of Dr. Hobart M. Smith I have been able to examine a large series of Utas from Morelos, Guerrero, Michoacán, and Oaxaca and Chiapas, which he has just recently returned with, after a protracted collecting trip in southern Mexico. A critical study of these specimens leaves no doubt that *bi-carinata* does in fact extensively intergrade with *anonymorpha* throughout the entire region from Acapulco east to Tierra Colorada, Guerrero. Specimens from the last named locality range from typical *anonymorpha* to typical *bi-carinata,* with every conceivable degree of arrangement of the hybrid characters. However, since the largest part of the specimens from Tierra Colorada are undeniably *anonymorpha,* I consider this point to be the westernmost range of this subspecies' distribution. The extension of the range of *anonymorpha* to include eastern Chiapas, is on the basis of two specimens collected by Dr. Smith at Tonolá; a very large male and an immature female, both, however, somewhat atypical. There is a strong possibility that specimens from more easterly Chiapas will prove to be distinct from *anonymorpha,* and these two examples may indicate some such tendency.

Generally speaking, *anonymorpha* is quite easily separated from *bi-carinata.* In males, the abbreviated blue abdominal patches are quite distinctive in *anonymorpha;* while the ventral coloration tends to take on the appearance of an evenly diffused wash in *bi-carinata* males. In specimens of either sex, *anonymorpha* can be told at once by its much less rugose appearance, and the definitely weaker carination of the enlarged dorsals. More often too, *anonymorpha* will possess an evenly mottled chin, whereas *bi-carinata* has a tendency to possess a light median area; this has already been noted by Smith (1935, p. 170). The holotype and paratypes on which the race is based agree very well with the series of 98 specimens taken by Smith.

Uta bi-carinata nelsoni Schmidt — Figs. 1H, 2

Uta nelsoni Schmidt, Amer. Mus. Nov., No. 22: 4. 1921.

Type locality.—Cuicatlam (=Cuicatlán), Oaxaca.

Type.—U. S. N. M. no. 46836.

Diagnosis.—Most closely allied to *bi-carinata* and *anonymorpha,* from which races it differs only as follows: Ventrals not mucronate; dorsolateral and lateral series of tubercular scales poorly developed; head narrower proportionately than in *bi-carinata,* and broader proportionately than in *anonymorpha;* enlarged dorsals smaller. Measurements of type: Snout to posterior

border of ear, 13.5 mm; head width, 10.5 mm; hind led (insertion to tip of 4th toe, exclusive of nail), 33.0 mm; snout to anus, 58.0 mm.

Distribution.—Restricted to the type locality.

Remarks.—*U. b. nelsoni* is designated as a subspecies of *bi-carinata* for the following reasons: The marked similarity in structure to the typical form and *anonymorpha;* the continuity and contiguity of its distribution with the *bi-carinata–anonymorpha* stock, the ranges of all three being juxtaposed; and the possibility that *nelsoni* represents an intermediate population in position between the *bi-carinata–anonymorpha* stock, and some form, as yet undescribed, from extreme northwestern Oaxaca and possibly southern Veracruz. The range of mountains just north of the city of Oaxaca have undoubtedly served to keep *nelsoni* isolated from *anonymorpha;* specimens from the immediate vicinity of this city will do much to clarify the relationships between *nelsoni* and the more southerly Oaxacan race.

Of this subspecies I have examined only the type specimen. This lone individual is distinct enough from *anonymorpha* and *bi-carinata,* but only on the basis of the characteristics given above. Other points of distinction given by Schmidt (*loc. cit.*) do not seem tenable.

Uta bi-carinata tuberculata Schmidt Figs. 1E, 2

Uta tuberculata Schmidt, Amer. Mus. Nov., No. 22: 4. 1921.

Type locality.—Colima, State of Colima.

Type.—A.M.N.H. no. 13737.

Diagnosis.—Most closely related to *bi-carinata,* from which it differs as follows: Enlarged dorsals larger, more regularly arranged; equal to, or larger than, the enlarged femoral and tibial scales; external to the enlarged dorsals but in contact with them, or separated by only one or two granules, there is a series of slightly enlarged scales, which are visibly keeled, but neither as large nor as prominent as the primary series of enlarged dorsals; dorsolateral and lateral tubercles and enlarged spinose scales very regularly arranged, but not as prominent as in *bi-carinata;* lowest series of lateral tubercles in contact with the ventrals, which are not sharply differentiated from the granular scales of the sides; ventrals rounded, occasionally submucronate; slightly keeled laterally; gular scales for the most part elongated and imbricate, save for a few immediately adjacent to the infralabials, which are granular and pavemented; frontal variable, usually divided transversely; postfemoral dermal pocket variable; coloration similar to *bi-carinata.* Measurements of type: Snout to posterior border of ear, 12.0 mm; head width, 9.0 mm; snout to anus, 45.0 mm; hind leg (insertion to tip of 4th toe, exclusive of nail), 27.0 mm.

Distribution.—Colima and Jalisco (Schmidt, *loc. cit.*); Presidio de Mazatlán, Sinaloa (Smith, 1935, p. 171); southern Sonora (20 miles southeast of Alamos).

Remarks.—Other than some slight variation in color and pattern, the specimens I have seen agree rather well with the type, differing only in a few minor points.

Because of a dearth of Utas from southern Sonora to central Jalisco, the

distribution of *tuberculata* is imperfectly known. First known from Jalisco and Colima, the type series remained unique until Smith (*loc. cit.*) reported on a specimen taken by him just south of Presidio de Mazatlán, Sinaloa, which extended the range northward for about two hundred miles. In the course of an examination of Mexican Utas in the collection of the Museum of Comparative Zoology I came upon two specimens, M.C.Z. nos. 37856–7, collected near Guirocabo, 20 miles southeast of Alamos, Sonora. These two specimens are quite typical of the subspecies, and on the basis of their locality, the range of *tuberculata* is extended northward again for another two hundred and eighty miles. Dr. Smith tells me in a letter that this closely corresponds to the distributional pattern of *Sceloporus nelsoni*.

U. b. tuberculata is obviously a member of the neotropical *bi-carinata* stock; just what its relationships with the nearctic *lateralis* might be must await the discovery of further specimens from Sinaloa, southern Sonora, and northern Jalisco.

Uta unica, sp. nov. Figs. 1D, 2, 3

Uta bicarinata Cope, Rept. U. S. Nat. Mus. for 1898: 320–322, fig. 43. 1900.

Holotype.—U. S. N. M. no. 14248, female, "Chihuahua," collected by Edward Wilkinson.

Diagnosis.—A medium-sized *Uta* belonging to the Mexican division of the *Uta ornata* complex, and characterized by only a single series of enlarged dorsal scales on each side of the enlarged vertebrals; general appearance not at all rugose; dorsal and ventral scales with a distinct tendency toward pavementation.

Description.—Cephalic scales comparatively smooth; frontal entire, separated behind from the interparietal by a pair of frontoparietals; rostral much wider than high; supralabials 5–5, the fourth and fifth subocular in position; infralabials 7–7; auricular opening anteriorly denticulated by several enlarged, granular scales; a few scattered enlarged scales on the nape and shoulders, extending caudad from a point just posterior of a line joining the insertions of the fore limbs, along the vertebral line onto the base of the tail for a distance subequal to the length of the femur, is a series of enlarged scales, bordered on each side by a single series of much larger scales, which are, however, inferior in size to the enlarged scales of the femur, but larger than the enlarged tibial scales; enlarged dorsal scales only weakly carinated, and prominently pavemented; external to the enlarged scales and in contact with them, or more often separated by the width of the vertebral series, is another series of enlarged scales, spaced about two scale lengths apart; these latter equal to or slightly smaller than the enlarged scales bordering the vertebral series; the outer enlarged scales often surrounded by minutely enlarged tubercular scales; on the dorsolateral, lateral, and ventrolateral areas are evenly dispersed four longitudinal series of small clusters of slightly enlarged, somewhat convex scales, which are not at all rugose; the lowermost of these rows of clusters barely in contact with the ventrals; ventral scales imbricate and mucronate anteriorly, but medially, laterally, and posteriorly, they become rounded and quite pavemented, again becoming spinose and imbricate as they approach the anal region; ventrals abruptly diminishing in size to meet the lateral scales; gular scales pavemented and rounded anteriorly, but mucronate and imbricate posteriorly, and no-

ticeably increasing in this tendency, until in the region of the gular fold the scales are longer than wide and distinctly spinose; gular fold extending laterally and dorsally around the anterior edge of the insertions of the fore limbs, and met by a heavy postauricular fold; caudal scales large, prominently keeled, spinose, and at least basally, in irregular whorls of three verticils, of which the first is always prominently larger; postfemoral dermal pocket absent. Coloration of holotype (alcoholic): Dorsum of head and body greenish gray, the head finely reticulated with light brown, and the body with two light brown bands which are narrow on the vertebral line and widen as

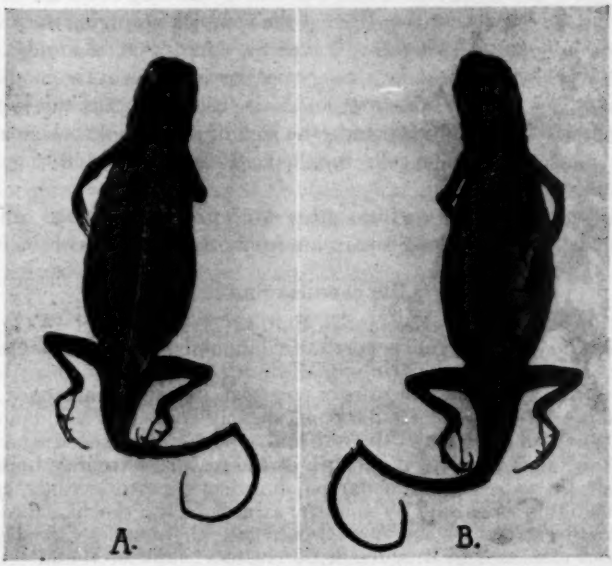

Fig. 3.—*Uta unica*, sp. nov.; type, U.S.N.M., no. 14248, female, Chihuahua, Mexico. Edward Wilkinson, collector. Actual length, snout to vent, 50.0 mm. (A) Dorsal view; (B) ventral view.

they progress laterally; dorsum of the body irregularly flecked and barred with dark brown; axillary, inguinal, lateral, prehumeral, postfemoral, and postanal regions washed with dark brown; an irregular, dark brown pectoral blotch; gular area and the remainder of the venter of body and tail a very pale greenish gray; limbs narrowly barred with light brown. Cope (*loc. cit.*) describes the specimen which was then fresh, as having "limbs and tail shaded with reddish brown," and says further that the "inferior regions tinted yellow lightly stippled with brown; males have the entire abdominal region a bluish gray." Measurements of holotype: Snout to posterior border of ear, 11.5 mm; head width, 9.0 mm; snout to vent, 50.0 mm; hind leg (insertion to tip of 4th toe, exclusive of nail), 26.5 mm; tail 52.0 mm.

Distribution.—At present known only from the southwestern (probably) corner of the state of Chihuahua.

Remarks.—This unique species is quite different from any other known *Uta*, and insofar as it can be determined, represents a dwarf offshoot of a probable pre-*tuberculata* stock. Although immediately recognized as being distinct, formal recognition of it was deferred until such a time as might bring to light further specimens. Since a careful examination of several extensive collections of Mexican Utas has failed to reveal any additional specimens, I have, at the suggestion of Dr. H. M. Smith, described the species in the hope that future collectors working in southern Chihuahua may have the good fortune of taking more specimens. A study of the distributional patterns of the only other two Utas of the complex occurring in Chihuahua (*U. o. schmidti* and *U. caerulea*) leaves no doubt that the only suitable unoccupied ecological niche for this species would occur in the mountainous southwestern portion of the state, and it is from here that the type probably emanated. I can only attribute the lack of additional specimens to the fact that since Wilkinson collectors have largely neglected this part of Chihuahua.

The distinctness of *unica* from other known Utas bespeaks quite a respectable age, as well as long separation from other members of the complex.

Uta caerulea Smith

Uta caerulea Smith, Univ. Kansas Sci. Bull. 12(7): 172–178, pl. 26 (3). 1935.

Type locality.—Thirty miles north of Chihuahua City, Chihuahua.

Type.—David H. Dunkle–Hobart M. Smith Coll. no. 132.

Diagnosis.—Two vertebral rows of enlarged, irregularly arranged, weakly carinated scales, extending from a point slightly craniad of a line joining the anterior points of insertion of the fore limbs, posteriorly onto the base of the tail for a distance equal to the length of the femur; vertebrals bordered on either side by two series of enlarged, imbricate, rather weakly carinated scales, the outer series slightly smaller; largest of the dorsal scales inferior in size to the largest of the tibials; dorsolateral tubercles but slightly enlarged, and dispersed in irregular little clusters; ventrals rounded, smooth, and imbricate; frontal transversely divided; a postfemoral dermal pocket present. Coloration of male (from original diagnosis, *loc. cit.*): Entire ventral surfaces of body and tail, except chest, base of tail, and an area between the hind legs, sky blue; dorsum with about seven transverse black bars on each side; bars usually blue-edged. Measurements of type (Smith, *loc. cit.*): Snout to anterior border of ear, 10.0 mm; head width, 10.0 mm; snout to vent, 49.5 mm; hind leg, 30.0 mm.

Distribution.—Within a radius of 30 miles of Chihuahua City, Chihuahua.

Remarks.—I include *caerulea* as a full species rather than as a subspecies with some reservations, as I have seen several specimens intermediate in character between *caerulea* and the newly described (Mittleman, 1940) *U. o. schmidti* from Texas and northern Chihuahua; these, however, bore only the data "Border," or "Mexico." I prefer to consider *caerulea* as a full species until the precise distribution of both forms in Chihuahua is completely mapped out.

Uta caerulea is the only species within the *ornata* complex wholly indige-

nous to Mexico, that is a member of the subgroup within the complex which features two nearly equal series of enlarged dorsals on either side of the enlarged vertebrals; this condition regularly obtaining in the species indigenous to the United States. The characteristics of *caerulea* are such that they appear to be but newly differentiated from the *U. o. ornata* and *U. o. schmidti* stock, a population which is in itself quite recent and still undergoing a proliferation as well as loss of numerous traits. Smith (*loc. cit.*) has distinguished between *caerulea* and *ornata* (=*schmidti*), and enumerated several salient points of difference. In the main, the following distinctions will serve to separate the two forms: in *caerulea*, the enlarged dorsals extending onto the base of the tail for a distance equal to the length of the femur; never more than half this distance in *schmidti;* largest of the enlarged dorsals inferior in size to the enlarged tibials, in *caerulea;* in *schmidti*, these scales are equal to, or larger than, the enlarged tibials; *caerulea* with the blue of the gular region extending to include the sublabials; in *schmidti*, the sublabials are white or gray, but always distinct from the gular region in coloration. Smith also remarks that *caerulea* may be told from *lateralis* by the commencement of the enlarged dorsals on the nape of the neck in the latter; also, the inner series of enlarged dorsals much larger in size than the outer series.

PHYLOGENY OF THE COMPLEX

The *Uta ornata* complex is defined as that group of lizards within the genus *Uta* which is characterized by the possession of one or more series of enlarged dorsal scales bordering a similar though smaller series of vertebral scales; the group is so-named because *Uta ornata ornata* was the first described form within it. In the United States, Mexico, Baja California, the islands within the Gulf of California, and at least two of the islands composing the Revillagigedo Archipelago, there occur 15 species and subspecies of Utas, which, by reason of the common bond previously defined, are assigned to this complex.

Smith (1935, p. 177) has postulated that the genera *Uta* and *Sceloporus* have shared a common ancestor, *Uta* being possibly a trifle older than *Sceloporus*. Smith states further that the *ornata* group may be considered the most primitive in the genus *Uta*, and the *mearnsi* group the most highly developed. I find Smith's hypothesis substantiated, and ascribe to it too. *Uta* may be fairly well separated into four groups, these, in the order of their complexity and evolution from oldest to newest, being *ornata–graciosa–stansburiana–mearnsi*. The trend, apparently, in *Uta* is from a rugose, carinated, enlarged scaled form to a minutely scaled, smooth form.

Within the *ornata* complex, *wrighti* (=*levis* of Smith, *et auct.*) is probably the most primitive species. The primitive *Uta ornata* fore-

bear can be described as a *Uta* bearing weakly carinated, irregularly arranged, numerous series of enlarged dorsals; poorly developed series of enlarged dorsolateral and lateral tubercles; ventrals rounded; of existing Utas, *wrighti* most closely approaches this hypothetical form. Without delving into the ramifications of the proliferation of species within the United States, let it suffice to say that *wrighti* gave rise directly to the more rugose, larger scaled *linearis* of southern Arizona and northern Mexico. At about the time of the early Oligocene, *linearis* spread southward into what is now northern Sonora, which existed in a continuous range of land with the present-day Gulf of California, Baja California, and western Mexico as far west as the Revillagigedo Archipelago. This era saw the submersion of the west coast of Mexico from southern Jalisco to and including the Yucatan Peninsula.

The vanguard of the *linearis* emigration must have been characterized by an extreme genetic instability, for the foremost of these lizards soon formed the *lateralis*, or actually pre-*lateralis*, stock. The stock must have been of an active, aggressive, and successful nature; it spread in all possible directions, and soon became established in numerous ecological situations. That these lizards possessed an extremely active genetic constitution, and bore several strains, is attested to by the fact that the recession of the southern waters which formed the Gulf of California, the several islands within the gulf, the Revillagigedo Archipelago, and left southern Mexico dry, left several populations comparatively isolated, and these soon differentiated into distinct forms. The pre-*lateralis* population promptly continued its southward trek, while the remaining members evolved into the modern *lateralis*. The two small groups of lizards that were isolated on Socorro and Clarion Islands, respectively, of the Revillagigedo Archipelago, offer remarkable proof of the diversity of this pre-*lateralis* stock; for *auriculata* of the former island bears a closer resemblance to *bi-carinata* and its affiliates than it does to either *lateralis* or the neighboring *clarionensis* of Clarion Island. Conversely, *clarionenis* is more nearly related to *lateralis* than to *auriculata* or any other existing form.

The emersion of southern Mexico probably took place during the early Miocene, and the expansion of the pre-*lateralis* stock followed the recession of the waters, hampered only by the high Sierra Madre on the east, and the Pacific Ocean on the west. This southerly migration was accompanied by the adoption of variously isolated niches as well as changing genetics which similarly contributed to the differen-

tiation of several new forms. Ultimately, this resulted in the evolution of the line *lateralis–tuberculata–bicarinata–nelsoni–anonymorpha*, the latter two races probably developing simultaneously, with their distinction being due to the isolation afforded the *nelsoni* stock by the high mountains just north of Oaxaca (city). Additional specimens from more easterly localities in Chiapas may reveal that a still undescribed race exists there, for this region was separated from the Tehuantepecan area by a post-Miocene immersion, and did not become continuous with it again until the Pliocene, thus affording ample time for the differentiation of another race. This has been found to be the case with certain *Cnemidophori* (Burt, 1931, p. 73). *Caerulea* is quite probably but a newly differentiated species, sprung from the *ornata-schmidti* stock, from which it differs only in degree.

In the study of the evolution and phylogenesis of the Mexican *Uta ornata* lizards, certain characteristics lend themselves very well as salient indicator factors to the examination of such trends. These are: (1) the number and size of the enlarged dorsals; (2) the form of the ventral scales; and (3) the absence or presence of a postfemoral dermal pocket. The last-named feature occurs in all the forms indigenous to the United States, is present too in *U. caerulea*, also in *lateralis*, is variable in *tuberculata* and *bi-carinata* (although most often absent in this latter race); is always absent in *unica*, *anonymorpha*, and *nelsoni*, is possibly rudimentary in *auriculata*, and absent in *clarionensis*. The trend from *lateralis* to *anonymorpha* is from a smooth, rounded ventral scale, to a carinated, spinose one. Again *auriculata* and *clarionensis* reveal their closer affinity to certain mainland forms than with each other, for *auriculata* possesses ventrals almost indistinguishable from those of *bi-carinata*, while those of *clarionensis* bear a remarkable resemblance to the condition obtaining in *lateralis*. The southward progression of the races reveals too that there is a steady decrease in the size and number of the enlarged dorsals, from *lateralis* to *anonymorpha*; *clarionensis* again resembling *lateralis*, and *auriculata* the southerly races. In all of its traits, *unica*, as its name implies, is quite unique. On the whole, however, it seems to be a specialized offshoot of the pre-*tuberculata* stock.

From the preceding discussion it will be readily seen that the members of the Mexican division at least, of the *Uta ornata* complex, define themselves into a clearcut example of a formenkreis. Although the races indigenous to the United States have not been included here, it may be added that they just as readily incorporate into a similar pattern. Ample opportunity for differentiation through isolation and

extreme genetic activity has resulted in the several diverse forms. It is this hyperactive state of genetics that has produced the innumerable mutants which gave rise to the different species and subspecies; whether the mutants produced will survive and because of a possibly changed physiology seek an unoccupied ecological niche in which they may successfully multiply, or whether they will remain within the genetic scope of the parental stock, and add to the sum-total of what taxonomists are pleased to call the normal variation of the species, is the needle's eye through which the latent species-in-the-making must pass. In the case of the Utas under consideration, at least, the passage seems to have been successfully navigated several times. The evolution of the Mexican lizards of the *ornata* complex can perhaps be best described as a case of dynamic orthogenesis accompanied by constantly changing physiologies, and the success or failure of the ecological niche occupied. This, then, follows the pattern of multiplication of species through the isolation and mutation of older species, as postulated by Dunn (1934). However, there is no implication that of necessity any of the ancestral features need survive. Kinsey (1936, p. 54) has pointed out that within a complex or formenkreis "each species gives rise to one or to a limited number of new types without modifying the specific status or the existence of the older species." Hence, although an older parental species may be well established, and the newer derivative species equally well established, there is no implication necessary on the basis of the successful existence of the newer species, that any traits of the older form must necessarily be present, or have some survival value. The very existence of the newer population, regardless of any characteristics common to both stocks, is ample proof of its success. Neither is there any need for the assumption that within a single cohesive group, as a complex or formenkreis, there must be a continuity of traits. These traits may well appear in several members of the complex, but they may equally well be absent. A genetic change which is sweeping enough to cause the physiology of a lizard to become so altered that it cannot tolerate the parental habitat, may in itself cause, or may be accompanied by a change that will cause an equally sweeping change of form.

In their distribution and evolution, the Mexican *Uta ornata* complex representatives bear a close resemblence to the patterns worked out for *Ctenosaura*, by Bailey (1928); there is an even more marked similarity in their distribution and specific proliferation with those worked out for the Mexican wasps of the genus *Cynips* by Kinsey (1936).

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PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

364TH MEETING OF THE BOARD OF MANAGERS

The 364th meeting of the Board of Managers was held in the Private Dining Room of the Cosmos Club on Friday, December 6, 1940. President CRITTENDEN called the meeting to order at 8:00 P.M., with 17 persons present.

President CRITTENDEN appointed G. W. VINAL, chairman, W. G. BROMBACHER, and J. W. MCBURNEY to constitute the Committee of Tellers to canvass the ballots in the annual election of officers for 1941.

President CRITTENDEN appointed H. E. MCCOMB, chairman, F. S. BRACKETT, and L. V. BERKNER to constitute the Committee of Auditors to examine the accounts of the Treasurer for the calendar year 1940.

C. L. GARNER, chairman of the Committee on Meetings, reported that all the meetings of the Academy through April, 1941, would be held in the present Assembly Hall of the Cosmos Club.

G. STEINER, chairman of the Committee on Membership, presented the names of 11 persons for membership in the Academy—9 resident and 2 nonresident.

The Corresponding Secretary presented for R. E. GIBSON, chairman of the Nominating Committee, the report of that committee on their nominations for officers for 1941:

For President.....AUSTIN H. CLARK
For Secretary.....FREDERICK D. ROSSINI
For Treasurer.....HOWARD S. RAPPLEYE
For Manager, to fill the unexpired term of two years, 1941 and 1942.....FRANK H. H. ROBERTS, JR.
For Manager, for the regular term of three years, 1941, 1942, and 1943; with two to be elected.....FERDINAND G. BRICKWEDDE
HENRY B. COLLINS, JR.
FRANK C. KRACEK
PAUL A. SMITH

In connection with the awards for scientific achievement, the following motion was made and carried by the Board: "The awards for scientific achievement announced at the annual meeting of the Academy in January shall be made for the preceding calendar year, and a candidate shall not have attained his 41st birthday during the year for which the award is made."

The Corresponding Secretary presented for the Committee of Tellers who counted the ballots on the three amendments to the bylaws submitted to the membership in October, 1940, which committee consisted of H. N. EATON, chairman, R. S. JESSUP, and B. J. MAIR, their report on the 150 ballots cast by the membership:

Amendment	*For*	*Against*
To restore the offices of the two nonresident vice presidents	94	50
To modify and clarify the procedure for amending the bylaws	133	15
To establish the position of Archivist, to discontinue the office of Recording Secretary, and to change the name of the office of Corresponding Secretary to Secretary	144	6

Since a two-thirds majority of the ballots cast is necessary for adoption, the first listed amendment was lost and the other two were carried.

The Corresponding Secretary reported the following statistics with regard to the membership: Deaths, 2; acceptances to membership, 11; resignations, 2.

In connection with the report of the Custodian of Publications, W. W. DIEHL, the following motion was made and carried: "The President is instructed to appoint a committee to consider (*a*) the number of copies of the Journal to be printed currently, (*b*) the limitations to be placed on the sale of back numbers of the Journal, and (*c*) the limitations, if any, to be placed upon the purchase of back numbers of the Journal to complete given volumes or entire sets of volumes." To constitute this committee, President CRITTENDEN appointed the Custodian of Publications, chairman, the Senior Editor, and the Treasurer.

The meeting adjourned at 10:00 P.M.

FREDERICK D. ROSSINI, *Corresponding Secretary.*

Obituaries

WILLIAM BOWIE, U. S. Coast and Geodetic Survey, retired, died at Mount Alto Hospital in Washington, D. C., on the morning of August 28, 1940, after an illness of less than a month. He was born in Anne Arundel County, Md., on May 6, 1872, the son of Thomas John and Susanne (Anderson) Bowie. He received his early education in the public schools and at private academies and later received degrees at Trinity College, Lehigh University, University of Edinburgh, Scotland, and George Washington University.

He entered the service of the Coast and Geodetic Survey on July 1, 1895, and served as a junior officer and later as Chief of Party in the field and was engaged principally on triangulation and base-line measurements in many States of the Union as well as in the Philippines, Puerto Rico, and Alaska. He was appointed chief of the Division of Geodesy in 1909 and rendered distinguished service in this position until he retired on December 31, 1936.

During the World War he was commissioned a major in the Corps of Engineers, U. S. Army, and served with the Mapping Division of the Office of the Chief of Engineers.

His development of the theory of isostasy gained him international recognition. He was awarded the Elliott Cresson medal in 1937 by the Franklin Institute of Philadelphia for his contributions to the science of geodesy. He was also awarded the Charles Lagrange prize by the Royal Academy of Belgium, 1932; made an officer in the Order of Orange-Nassau by the Queen of the Netherlands in 1937; and received the decoration of the Cross of Grand Officer of the Order of St. Sava from Yugoslavia in 1939.

The first impression of the medal of the American Geophysical Union, known as the William Bowie Medal and established for award for distinguished attainment and outstanding contribution to the advancement of cooperative research in fundamental geophysics, was presented to Major Bowie at the meeting of the Union in April, 1939.

Major Bowie was interested in many scientific societies and organizations to which he contributed much of his time. He was president of the Washington Society of Engineers, 1914; president of the Philosophical Society of Washington, 1926; president of the Washington Academy of Sciences, 1930; chairman of the American Geophysical Union, 1919–22 and 1929–32; chairman of the Board of Surveys and Maps of the Federal Government, 1922–24; member of the Committee on Surveying and Mapping, American Engineering Council; president of the Society of American Military Engineers, 1938; chairman of the Division of Surveying and Mapping of the American Society of Civil Engineers since its organization in 1926; president of the District of Columbia chapter of the Society of Sigma Xi, 1935–36; honorary president of the Pan American Institute of Geography and History, 1929 to 1940; president of the International Geodetic Association, 1919–33; and president of the International Union of Geodesy and Geophysics, 1933–36. He was appointed executive secretary of the Society of American Military Engineers in December, 1939, and served in that capacity and as editor of the Society's magazine until his death.

EDWARD BROWNING MEIGS, formerly chief of the Division of Nutrition and Physiology of the U. S. Bureau of Dairy Industry, died on November 5, 1940, after a long illness. He was born in Philadelphia on September 10, 1879, and received an A.B. degree from Princeton University in 1900. He

was graduated from the Medical School of the University of Pennsylvania in 1904 and remained there for two years as instructor in physiology.

In 1904 he took the course in physiology at the Marine Biological Laboratory and spent the following year at the University of Jena, doing research work in the physiology of muscular contraction. He was instructor in physiology at the Harvard Medical School from 1907 to 1910 and in 1910 was fellow in physiology at the Wistar Institute. He came to the Bureau of Dairy Industry in 1915 to take charge of the laboratory for the study of the nutrition of dairy cows. This laboratory was situated at Beltsville, Md., but for administrative purposes was a part of the Washington laboratories. However, Dr. Meigs was, from the beginning, entirely responsible for the research work and when, in 1936, all the work of the Bureau of the physiology of reproduction, milk secretion, and nutrition was combined he became chief of the newly created division.

The results of his work previous to entering the Government service were presented in 15 papers, many of which dealt with problems of muscular contraction. In his work at Beltsville he made a notable contribution to the knowledge of the mineral metabolism of the dairy cow and of the part of the roughage in supplying minerals and essential vitamins to milking cows. The results of this work were presented in 27 papers in various journals and Department of Agriculture publications.

The interference with the nutrition investigations by outbreaks of mastitis in the herd forced Dr. Meigs to give considerable attention to a study of the factors influencing the incidence of this disease, a problem that he attacked with characteristic thoroughness and freedom from the bias imposed by preconceived theories. Although this work was curtailed by the onset of impaired health, he was able to demonstrate that in the nutrition herd mastitis could be produced or cured almost at will by the control of physical conditions.

In his last few years his strength was so reduced by the inroads of disease that he was obliged to give up the administrative work of his position and to confine his efforts to the preparation for publication of results that had accumulated in his active years. It was characteristic of his devotion to his work that one of his last acts was to insure the safety of a manuscript on which he had been working intermittently as his waning strength permitted for three years.

As chief of a laboratory he was a leader rather than a director. His interest was always in the study of fundamental principles rather than in the more superficial feeding experiments with their practical application. Among his scientific achievements should be included the organization of the staff that he gathered about him and in which he inculcated his own high ideals of service. He will be remembered by those who were fortunate enough to be among his friends and acquaintances for his scholarly attainments, his gentle and courteous manners, and his unfailing generosity in thought and action.